
प्लास्टिक — परीक्षण पद्धतियाँ

भाग 9 प्रकाशिक गुणधर्म

अनुभाग 7 प्लास्टिक फिल्मों और ठोस प्लास्टिकों की परावर्तक चमक ज्ञात करना

(पहला पुनरीक्षण)

Plastics — Methods of Test

Part 9 Optical Properties

Section 7 Determination of Specular Gloss of Plastic Films and Solid Plastics

(First Revision)

ICS 83.140.10

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FOREWORD

This Indian Standard (Part 9/Sec 7) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Methods of Sampling and Test for Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

This Indian Standard was first published in 2001. This revision has been under taken to make the editorial corrections.

Specular gloss is used primarily as a measure of the shiny appearance of films and surfaces. Precise comparisons of gloss values are meaningful only when they refer to the same measurement procedure and same general type of material. In particular, gloss values for transparent films shall not be compared with those for opaque films, and vice versa. Gloss is a complex attribute of a surface which cannot be completely measured by any single number.

Specular gloss usually varies with surface smoothness and flatness. It is sometimes used for comparative measurements of these surface properties.

The composition of the Committee responsible for the formulation of this standard is given in [Annex A](#).

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'.

Indian Standard

PLASTICS — METHODS OF TEST

PART 9 OPTICAL PROPERTIES

SECTION 7 DETERMINATION OF SPECULAR GLOSS OF PLASTIC FILMS AND SOLID PLASTICS

*(First Revision)***1 SCOPE**

This standard describes a method for the measurement of gloss of plastic films and solid plastics, both opaque and transparent. It contains three separate gloss angles:

- a) 60°, recommended for intermediate-gloss films;
- b) 20°, recommended for high-gloss films; and
- c) 45°, recommended for intermediate and low-gloss films.

2 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

2.1 Specular Gloss, n

2.1.1 Ratio of flux reflected in specular direction to incident flux for a specified angle of incidence and source and receptor angular apertures.

2.1.2 Perceived surface brightness associated with the luminous specular (regular) reflection of a surface (CIE).

2.2 Gloss Reflection Factor, R_s , n — Ratio of the specularly reflected part of the (whole) flux reflected from the specimen to the flux reflected from a specified gloss standard under the same geometric and spectral conditions of measurement.

2.3 Discussion — The gloss standard may be a black glass or a mirror and may be assigned one of a variety of scale values as specified.

2.4 Relative Luminous Reflectance Factor — The ratio of the luminous flux reflected from a specimen to a standard surface under the same geometric conditions. For the purpose of measuring specular gloss, the standard surface is polished glass.

3 APPARATUS**3.1 Instrumental Components**

Each apparatus shall consist of an incandescent light source furnishing an incident beam, means for locating the surface of the specimen, and a receptor located to receive the required pyramid of rays reflected by the specimen. The receptor shall be a photosensitive device responding to visible radiation.

3.2 Geometric Conditions

The axis of the incident beam shall be at one of the specified angles from the perpendicular to the specimen surface. The axis of the receptor shall be at the mirror reflection of the axis of the incident beam. With a flat piece of polished black glass or other front-surface mirror in specimen position, an image of the source shall be formed at the centre of the receptor field stop (receptor window). The length of the illuminated area of the specimen shall be equal to not more than one third of the distance from the centre of this area to the receptor field stop. The angular dimensions and tolerances of the geometry of the source and receptor shall be as indicated in [Table 1](#). The angular dimensions of the receptor field stop are measured from the centre of the test surface. The angular dimensions of the source field stop are most easily measured by the specimen-to-window angular size of the mirror image of the source formed in the receptor field stop. (see [Fig. 1](#) for a generalized illustration of the dimensions). The tolerances are chosen so that errors of no more than one gloss unit at any point on the scale will result from errors in the source and receptor aperture.

3.3 Vignetting

There shall be no vignetting of rays that lie within the field angles specified in [3.2](#).

Table 1 Angular Dimensions and Tolerances of Geometry of Source and Receptor Field Stops
(Clause 3.2)

SI No.	Geometry	Incidence Angle	Source Field Stop		Receptor Field Stop	
			In Plane of Measurement,	Perpendicular to Plane of Measurement,	In Plane of Measurement,	Perpendicular to Plane of Measurement,
(1)	deg	deg	deg	deg	deg	deg
(2)	(3)	(4)	(5)	(6)	(7)	(7)
i)	60	60 ± 0.1	0.75 ± 0.25	≤ 3.0	4.4 ± 0.1	11.7 ± 0.2
ii)	20	20 ± 0.1	0.75 ± 0.25	≤ 3.0	1.80 ± 0.05	3.6 ± 0.1
iii)	45	45 ± 0.1	1.4 ± 0.4	3.0 ± 1.0	8.0 ± 0.1	10.0 ± 0.2

3.4 Spectral Conditions

Results shall not differ significantly from those obtained with a source-filter-photocell combination that is spectrally corrected to yield CIE luminous efficiency with CIE source C. Since specular reflection is, in general, spectrally non-selective, spectral corrections need be applied only to highly chromatic, low-gloss specimens upon agreement of users of this standard.

3.5 Measurement Mechanism

The receptor-measurement mechanism shall give a numerical indication that is proportional to the light flux passing the receptor field stop within ± 1 percent of full-scale reading.

4 REFERENCE STANDARDS

4.1 Primary Working Standards

May be highly polished, plane, black glass surfaces. The specular reflectance, in percent, (R_s) of such surfaces shall be computed by the following equation:

$$R_s(\text{percent}) = 50 \left[\frac{\left[\cos i - \sqrt{n^2 - \sin^2 i} \right]^2}{\left[\cos i + \sqrt{n^2 - \sin^2 i} \right]^2} + \frac{\left[n^2 \cos i - \sqrt{n^2 - \sin^2 i} \right]^2}{\left[n^2 \cos i + \sqrt{n^2 - \sin^2 i} \right]^2} \right]$$

where

i = specular (incidence) angle; and
 n = index of refraction of the surface.

Multiply the computed R_s at each angle by the scale factors given in Table 2.

NOTE — On the 45° and 60° scales, a perfect mirror measures 1 000.

4.2 Secondary working standards of ceramic tile, glass, porcelain enamel, or other materials having hard, flat, and uniform surfaces maybe calibrated from the primary standard on a gloss meter determined to be in strict conformance with the requirements prescribed in 3.2.

5 PREPARATION AND SELECTION OF TEST SPECIMENS

5.1 This standard does not cover preparation techniques. Whenever a test for gloss requires the preparation of a test specimen, report the technique of specimen preparation.

5.2 Specimen surfaces shall have good planarity, since surface warpage, waviness, or curvature may seriously affect test results. The directions of machine marks, or similar texture effects, shall be parallel to the plane of the axes of the two beams, unless otherwise specified (note that this does not avoid the second-surface reflection).

Table 2 Scale Factors for Gloss Standards, Perfect Mirror and Perfect Matt White¹⁾
(Clause 4.1)

SI No.	Geometry	Scale Factors (Multiply R_s of Black Glass Standard by)	Value for Black Glass When $n = 1.540$	Value for Perfect Mirror	Value for Perfect Matt White
(1)	(2)	(3)	(4)	(5)	(6)
i)	60°	10.0	95.8	1 000	2.1
ii)	20°	20.3	92.8	2 030	1.4
iii)	45°	10.0	55.9	1 000	5.4

¹⁾ The latter are useful for estimating corrections to gloss readings for reflection from sample backing (see Note under 4.1 and 7.4).

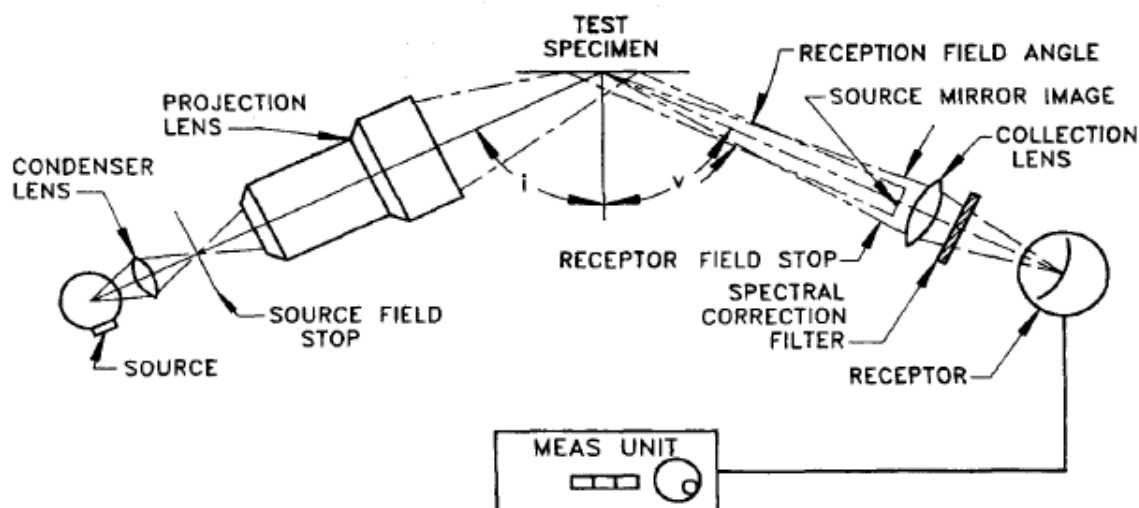


Fig. 1 DIAGRAM OF GLOSSMETER SHOWING ESSENTIAL COMPONENTS

5.3 Surface test areas shall be kept free of soil and abrasion. Gloss is due chiefly to reflection at the surface, therefore, anything that changes the surface physically or chemically is likely to affect gloss.

6 MOUNTING FILMS FOR MEASUREMENT

6.1 Any non-rigid film shall be mounted in a device that will hold it flat, but will not stretch it while it is measured. Three different film holding devices have each proved satisfactory for at least some types of films.

6.1.1 Vacuum plate (see Fig. 2) is required for stiff films. Connect the vacuum plate by rubber tube to a vacuum pump or vacuum line. With thin, soft films it is sometimes necessary to use a valve and pressure

gauge and to limit the vacuum so as to keep from collapsing the soft film into the pores of the ground plate.

6.1.2 Flat plate with two-side pressure-sensitive tape (see Fig. 3). Make sure each specimen is pulled smooth, but not stretched before holding it by the two strips of adhesive tape. Replace the tape whenever it loses its adhesiveness.

6.1.3 Telescoping ring or hoop (see Fig. 4) to mount the specimen in the telescoping ring, lay the flexible film over the base (male) section and drop the top over the base. Push down carefully, taking care to pull the test film taut without stretching it. Measure the taut area.

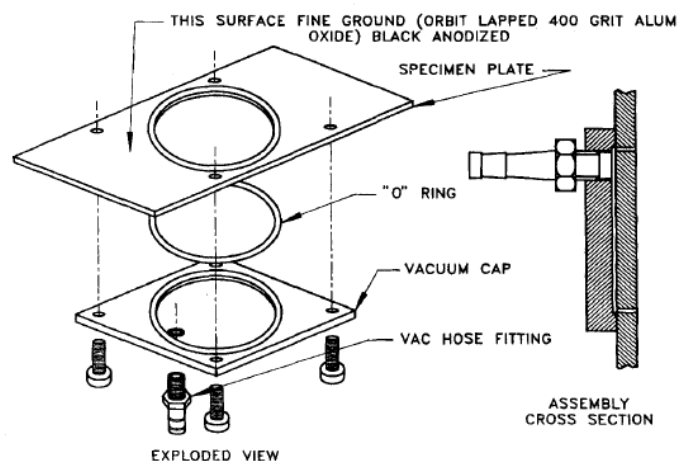


FIG. 2 VACUUM PLATE USED TO HOLD FILMS FLAT

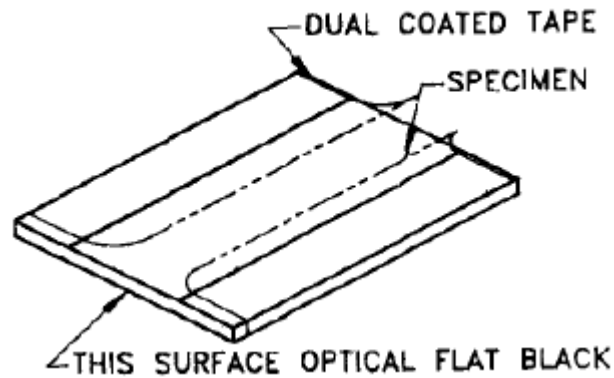


FIG. 3 FLAT PLATE WITH TWO-SIDED PRESSURE SENSITIVE TAPE USED TO HOLD FLEXIBLE FILMS FOR GLOSS MEASUREMENT

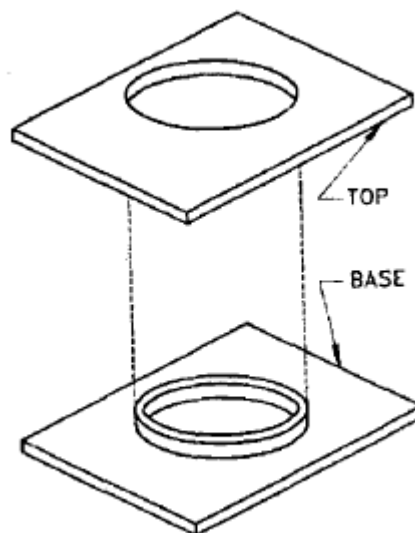


FIG. 4 TELESCOPING RING USED TO HOLD FLEXIBLE FILMS FOR GLOSS AND HAZE MEASUREMENTS

6.2 Backing for Films that Transit Light

A matt black backing or (even better) a black cavity shall be placed behind any film that transmits light. Erroneous measurements will occur without a suitable trap or backing.

7 PROCEDURE

7.1 Operate the gloss meter in accordance with the manufacturer's instructions.

7.2 Calibrate the instrument at the start and completion of every period of gloss meter operation and during the operation at sufficiently frequent intervals to assure that the instrument response is practically constant. If at any time an instrument fails to repeat readings of the standard to within 2 percent of the prior setting, the intervening results should be rejected. To calibrate, adjust the

instrument to read correctly the gloss of a highly polished standard, and then read the gloss of a standard having poorer image-forming characteristics. If the instrument reading for the second standard does not agree within 1 percent of its assigned value, do not use the instrument without readjustment, preferably by the manufacturer.

NOTE — Correct readings on the black-glass and intermediate standards do not guarantee instrument conformity to specification requirements. In addition to measurements with gloss standards, dimensional checks for conformity to the geometric requirements shall be made.

7.3 Reduction of Amplification to Read Over 100 Gloss Films on 0 to 100 Gloss Scale

A single smooth surface with refractive index of 1.567 measures 100 on both the 60° and 20° scales. Clear plastic films have two specularly reflecting surfaces. Even though they are less than perfectly smooth and less than 1.567 in refractive index,

adding the reflections from the two surfaces frequently leads to gloss values of more than 100. If these gloss values are off scale on the gloss meter used, recalibrate the instrument with the reading of the primary gloss standard set to a smaller value f (such as $f = 50$) and correct the gloss readings by multiplying them by $(100/f)$.

7.4 Position each specimen (mounted in a holder in the case of films) in turn beneath (or on) the gloss meter. For specimens with extrusion lines or other direction texture effects, orient them in such a way that direction of the marks is parallel to the plane of the axes of the incident and reflected beams. Measure at least three portions of the specimen surface to obtain an indication of uniformity.

NOTE — In the case of films, it is often desirable to compare these readings with readings taken across the machine direction. Difference in the readings will relate to the prominence of the machine marks.

8 REPORT

The test report shall include the following information:

- a) Type of specimen, its gloss (mean of three readings), nominal thickness, whether transparent, and the specimen holder employed if specimen is a film;
- b) All the individual gloss readings for a specimen shall be reported if any of the gloss

readings differ by more than 10 percent from the average, for that specimen;

- c) Where preparation of the test specimen has been necessary, description or identification of the method of preparation;
- d) Identification of the gloss meter by the manufacturer's name and model designation; and
- e) Identification of the working standard or standards of gloss used.

NOTE — Diffuse correction shall be done. It can be said that the light reflected by a specimen may be divided into one part reflected specularly in the direction of mirror reflection (associated with gloss) and another part reflected diffusely in all directions (associated with lightness on the white grey black scale). According to this picture, a gloss reading always needs to be diminished to compensate for that amount of the measured light attributable to diffuse reflectance. Although it is seldom possible in practice to analyze reflected light according to this picture and say exactly what part is diffuse and what part is specular, it is nevertheless frequent practice where gloss values of light and dark surface are being compared to 'correct' (diminish) specular gloss settings for diffuse reflectance. If diffuse corrections are desired as additional information, measure 45° , 0° luminous directional reflectance of specimens. Multiply reflectance values in percentage by the following factors for diffuse corrections in gloss units:

60°	0.021
20°	0.013
45°	0.055

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Methods of Sampling and Test for Plastics Sectional Committee, PCD 27

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